FORM PTO-1390 (Modified) (REV 11-2000) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

JC10 Rec'd PCT/PTO 08 JAN 2002

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER	10541-751 - 198-1516
U.S. APPLICATION NO (IF KNOWN, SEE 37 CFR 1 5)	10/030596

INTERNATIONAL APPLICATION NO	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/GB00/02595	05 July 2000	08 July 1999

TITLE OF INVENTION
Optical Media Pickup Anti-Rattle

APPLICANT(S) FOR DO/EO/US
Kevin Gallichan, Nicholas J. Robberts, Dean Miles, and Anthony Edward

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U S C. 371
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) The submission must include itens (5), (6), (9) and (24) indicated below.
4. ☐ The US has been elected by the expiration of 19 months from the priority date (Article 31)
5. ☒ A copy of the International Application as filed (35 U.S C 371 (c) (2))
   a. ☐ is attached hereto (required only if not communicated by the International Bureau)
   b. ☒ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C 371(c)(2)).
   a. ☐ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U S C. 371 (c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau)
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made, however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U S C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U S.C 371 (c)(4))
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).
11. ☒ A copy of the International Preliminary Examination Report (PCT/IPEA/409)
12. ☒ A copy of the International Search Report (PCT/ISA/210).

Items 13 to 20 below concern document(s) or information included:

13. ☐ An Information Disclosure Statement under 37 CFR 1 97 and 1.98
14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3 28 and 3.31 is included
15. ☒ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter
19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter 2 and 35 U.S.C. 1.821 - 1 825.
20. ☐ A second copy of the published international application under 35 U S.C. 154(d)(4).
21. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
22. ☒ Certificate of Mailing by Express Mail
23. ☐ Other items or information·

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U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR 1.5)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
10/030596	PCT/GB00/02595	10541-751 - 198-1516

24. The following fees are submitted:.				CALCULATIONS	PTO USE ONLY
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :					
☐ Neither international preliminary examination fee (37 CFR 1 482) nor international search fee (37 CFR 1 445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1040.00**					
☒ International preliminary examination fee (37 CFR 1 482) not paid to USPTO but International Search Report prepared by the EPO or JPO . . **$890.00**					
☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1 445(a)(2)) paid to USPTO **$740.00**					
☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$710.00**					
☐ International preliminary examination fee (37 CFR 1 482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**					
ENTER APPROPRIATE BASIC FEE AMOUNT =				**$890.00**	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).				**$0.00**	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	12 - 20 =	0	x $18.00	**$0.00**	
Independent claims	1 - 3 =	0	x $84.00	**$0.00**	
Multiple Dependent Claims **(check if applicable)**.			☐	**$0.00**	
TOTAL OF ABOVE CALCULATIONS =				**$890.00**	
☐ Applicant claims small entity status See 37 CFR 1 27) The fees indicated above are reduced by 1/2				**$0.00**	
SUBTOTAL =				**$890.00**	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)) +				**$0.00**	
TOTAL NATIONAL FEE =				**$890.00**	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).** ☐				**$0.00**	
TOTAL FEES ENCLOSED =				**$890.00**	
				Amount to be: refunded	$
				charged	$

a. ☐ A check in the amount of ________ to cover the above fees is enclosed.

b. ☒ Please charge my Deposit Account No **06-1500** in the amount of **$890.00** to cover the above fees. A duplicate copy of this sheet is enclosed

c. ☐ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No ________ A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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Steven L. Oberholtzer
NAME

30,670
REGISTRATION NUMBER

January 8, 2002
DATE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventors:	Gallichan et al.	)
Serial No.:		)
Filed:		) **PRELIMINARY**
For:	Optical Media Pickup Anti-Rattle	) **AMENDMENT**
Group Art Unit:		)

Commissioner of Patents and Trademarks
Washington, D.C. 20231

Sir:

Preliminary to examination of the above-referenced application, the following preliminary amendment is being submitted for consideration by the examiner.

IN THE SPECIFICATION:

Amendments to the specification are being made to pages 1, through 14 of the original application. As indicated on attached Appendix A, text being deleted is bracketed and text being inserted is underlined. Appendix B is a clean version specification incorporating the changes with line number being deleted and paragraph numbering being added.

IN THE CLAIMS:

Claims 2 through 12, pages 15 through 17, are being amended. As indicated on attached Appendix A, text being deleted is bracketed and text being inserted is underlined. Appendix B is a clean version of the claims incorporating the changes.

Respectfully submitted,

By: ______________________
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Dated: January 8, 2002

Docket No.: 10541-751

APPENDIX A

Optical Media Pickup Anti-rattle

BACKGROUND AND SUMMARY OF THE INVENTION

The present invention relates to an optical media system for suppressing externally induced rattle of an optical media pickup.

Optical media, such as optical discs, card or tape, are usually read and/or written to by an optical pickup containing an objective lens mounted in a voice coil actuator which performs focus and optionally tracking on the optical media. The objective lens is normally mounted in a carriage on a suspension, for example at the ends of flexible or hinged arms, with a biasing means that biases the lens to a neutral position often at the centre of a focus[s]ing range of about ± 1 mm. The focus motor is usually a voice coil actuator which moves between limits such as end stops that protect the focus actuator or lens from potential mechanical damage.

During normal operation in focus[s]ing on optical media, the end stops should never be reached, as a focus servo will keep the pickup focus[s]ed on the optical media. When the optical pickup is not being used, it may be moved off to one side of the optical media, so that the lens is no longer in position to read [/] or write to [/] or from the media.

The inventors have noted a problem with Compact Disc (CD) optical pickups in motor vehicles. Engine, road and wind

noise reduction and rattle elimination [is] are always desirable to provide for a quieter ride. In a very quiet car, rattles were noted in [a] the CD player when the car was driven on a bumpy surface. The source of the noise was traced to the CD pickup hitting the focus end stops when the pickup was in a parked position, owing to vertical vehicle movement and vibrations.

It is an object of the present invention to provide an optical media pickup with improved rattle characteristics.

Accordingly, the invention provides an optical media system comprising: an optical pickup for reading from and/or writing to an optical storage medium, the optical pickup having one or more sources of light, an objective lens, a focus and/or tracking actuator for moving the lens to focus and/or track the light on the optical medium and mechanical limits to limit the focus and/or tracking movement of the lens; and an actuator controller for controlling the actuator and hence the focus and/or tracking position of the lens, characterised in that the actuator controller actively controls the lens position when the optical pickup is not being used with the optical medium.

Because the focus lens position is controlled, rattling of the actuator is suppressed or eliminated.

The mechanical limits may be defined by the construction of the optical pickup, for example, being provided by end stops about the lens and separated by a spacing along an axial focus direction of the lens, or along a tracking

direction transverse to the axial position.

The light may be any suitable visible or invisible light source, for example, near infra-red laser light or LED light.

The term optical media systems includes optical disc, tape, and card systems. These include read-only systems such as those using compact disc media and read/write/erase systems such as those using magneto-optic data disc media.

The optical pickup will in general include focus detection means which generates a focus error signal when the pickup is used to read from or write to the optical medium. The optical disc system will then contain focus servo electronics so [that] the focus actuator can be moved to keep the objective lens positioned correctly for focus on the optical medium.

In a preferred embodiment of the invention, the optical pickup is moved to a park position away from the optical medium when not being used with such an optical medium. Then, the system can include a focus object at the park position so [that] the actuator controller can focus the light on the focus object when the optical pickup is not being used with the optical medium in order to hold the lens focus position within the mechanical limits.

The focus object may advantageously be made to have similar optical characteristics to those of the optical medium. For example, if the optical medium has a

transparent substrate through which the light is focussed to an information-bearing layer, then the lens will normally be adapted to focus light through this substrate in order to read and/or write to the optical medium. This is because focus[s]ing light through a planar substrate will introduce spherical aberration, which would result in an increase in focus spot size. The light from the focus lens is therefore pre-aberrated with an opposite spherical aberration so [that] this aberration is cancelled after the light has traversed the correct thickness of substrate.

The focus object may then include a substrate similar to that of the optical medium. This gives the advantage of reducing any adverse affects on focus due to dust or dirt on the focus object.

Because in practice the focus object cannot be perfectly reflective, the light on the focus object will generate heat where this is focus[s]ed. Therefore, the focus actuator may control the lens position when the optical pickup is not being used with the optical medium so that the focus of light on the focus object is defocused in order to reduce the illuminance on the focus object. In this way, the heat generated by the focus[s]ed light may be reduced.

Such an optical defocus may be obtained by injecting a focus offset signal into the electronic focus servo loop to the focus actuator.

Alternatively or additionally, the light may be pulsed on

the focus object in order to reduce the average illuminance. When the focus servo uses light returned from the focus object to generate a focus error signal for a feedback servo to the focus actuator, the pulsing of light should be set so that a sufficiently strong focus error signal may still be generated. Because the focus object is fixed, unlike the optical medium, the average light intensity on the focus object may be made less than that on the optical medium.

The focus object may contain thermally conductive material for dissipating heat absorbed from the focus light. For example, the focus object may include a reflective layer on which the focus actuator focuses, the thermally conductive material being a thickness of the reflective layer significantly beyond that needed for bulk reflectivity.

For example, in the case of an aluminium reflector layer, about 40 nm to 50 nm thickness is needed in order to achieve a bulk reflectivity of about 95% at 830 nm. If the thickness is increased to about 250 nm, [then] the aluminium layer will be able to conduct about five times as much heat from the focus area.

The focus or tracking actuator may be a voice coil actuator, the actuator controller being connected to the voice coil actuator and including circuitry that detects a voltage or a current generated by externally induced movement of the voice coil when the optical pickup is not being used with the optical medium, in order to generate a compensating voltage or current in order to control the

lens position.

The optical pickup may have at least one end stop that defines a limit to the focus and/or tracking movement of the lens. The actuator controller can then bias the lens towards an end stop when the optical pickup is not being used with the optical medium so [that] the lens position is held at the end stop.

Alternatively, when the optical pickup has a pair of end stops that define a limit to the focus (or tracking) movement of the lens, the actuator controller may control the lens position to a median position between the end stops.

The optical media system may be used in a vehicle, such as a motor car, comprising a motive means by which the vehicle may be energi[s]zed to move. The vehicle will in general have an electrical power source to power the optical media system. The actuator controller then actively controls the focus position of the lens when, and preferably only when, the vehicle is energi[s]zed to move.

The invention will now be further described, by way of example, with reference to the accompanying drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic view of a focus and tracking actuator of an optical pickup as seen from inside the pickup along the optical axis of an objective lens;

Figure 2 is a cross-section through the actuator of Figure 1, taken along line II-II;

Figure 3 is a cross-section through the actuator of Figure 1, taken along line III-III;

Figure 4 is a schematic drawing of an optical media system according to a first embodiment of the invention, showing an optical pickup with the actuator of Figure 1, with associated control electronics and an optical disc;

Figure 5 is a plot of focus error signal against defocus distance;

Figure 6 is a schematic drawing showing how defocus and a relatively thick reflector layer can be used to reduce heat absorbed from a focus spot of the optical pickup;

Figure 7 is a schematic drawing of an optical media system according to a second embodiment of the invention; and

Figure 8 is a schematic drawing of an optical media system according to a third embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Figures 1, 2 and 3 show a focus and tracking voice coil actuator 1 of conventional design for an optical pickup.

The focus actuator 1 has an objective lens 2 with a numerical aperture of 0.6 held in a surrounding cradle 4. The surrounding cradle 4 supports pairs of coils 6,8. One pair of coils 6 has a common axis 10 transverse to an optical axis 12 of the lens, and serves as a tracking actuator. The other pair of coils 8 has a common axis coincident with the optical axis 12 and serves as a focus actuator 1.

When electrical current is passed through [a] the pair of coils 6,8, this generates a magnetic field which then interacts with a permanent magnetic field produced by a pair of permanent magnets 14 on opposite sides of the optical axis 12, in order to drive the surrounding cradle 4 and objective lens 2 along either the tracking axis 10 or the focus axis 12.

The surrounding cradle 4 is supported by four straight suspension wires 16,17,18,19, which are arranged in pairs 16,17 and 18,19. As shown in Figure 2, one pair of suspension wires 16,17 is generally above the coils 6,8 and the other pair of suspension wires 18,19 is generally below the coils 6,8. The suspension wires 6, 17, 18, 19 all terminate at one end away from the surrounding cradle 4 at corresponding electrical terminals 20 on a terminal block 22, and at the other end to corresponding terminals 24 to which ends of the coils 6,8 are wired. Therefore, current to drive the focus [and tracking] actuator 1 is supplied to the coils 6, 8 through the suspension wires 16-19.

Tension in the suspension wires 16-19 when these are moved

away from a neutral position creates biasing forces, which will tend to return the surrounding cradle 4 to a neutral position.

The terminal block supports a frame 26 that extends fully around the surrounding cradle 4 in a plane transverse to the optical axis 12 of the objective lens 2.

The frame 26 in turn supports a pair of end stops 28,30 shown most clearly in Figure 2, one of which focus end stop 28 extends frame-like about the optical axis 12 above the surrounding cradle 4, and the other of which focus end stop 30 consists of a pair of ledges 31,32 that are inwardly directed towards the objective lens 2 in a plane generally below the surrounding cradle 4.

When the focus actuator 1 is driven fully inwards, a top surface 34 of the surrounding cradle 4 contacts the upper stop 28, and when the focus actuator 1 is driven fully outwards, a bottom surface 35 of the surrounding cradle 4 contacts the lower stop 30.

The frame 26 has a pair of inwardly directed projections, tacking end stops 36,37, which act as stops in the tracking direction.

The focus [and tracking] end stops 28,30, and tracking end stops 36,37 act to protect the focus and tracking actuator 1, and particularly the suspension wires 16-19, from mechanical damage which would occur at an extreme movement of the surrounding cradle 4 relative to the terminal block 22.

It has been discovered that in a motor car, vibrations from the road cause a rattling between the surrounding cradle 4 and focus end stops 28,30, but not between the surrounding cradle 4 and tracking end stops 36, 37. There are two reasons for this. One is that vibrations tend to be strongest in a vertical direction, which normally coincides with the optical axis 12, and the other is that the stiffness of the suspension wire to movement of the surrounding cradle 4 in the tracking direction can be greater than in the focus direction. This difference in stiffness is due to the fact that the required frequency response of [the] a tracking actuator is less than that required from the focus actuator 1.

Figure 4 shows a first embodiment of the invention 40, in which the focus [and tracking] actuator 1 is incorporated in a conventional optical disc pickup 41. The pickup 41 is shown focus[s]ing a beam of laser light 42 from the lens 2 onto a compact disc (CD) 43. The pickup 41 is mounted on rail 39 of a conventional linear tracking actuator 44 driven by a coarse tracking motor (TM) 45. The tracking motor 45 can move the optical pickup 41 so that the lens 2 can focus on an innermost portion 46 the CD 43. When the pickup 41 is not being used to read from the CD, the tracking motor 45 can move a distance 47 the [optical] pickup 41 away from the CD 43 to a park position 48, as shown by the [optical] pickup 41 drawn in phantom.

A focus object 50 is provided at the park position 48 on which the lens 2 may focus. The focus object 50 consists of a an aluminium reflector layer 51 encapsulated by a

transparent substrate 52 of 1.1 mm thick polycarbonate, a lacquer backing layer 53, held in a surrounding moulded plastic cup 54.

When the lens 2 is focus[s]ed on the focus object 50, the position of the surrounding cradle 4 along the focus axis 12 is actively controlled so that the surrounding cradle 4 is restrained from rattling against the focus end stops 28,30.

A person skilled in the art will be familiar with the conventional operation of an optical pickup, and so this will be described only briefly. The optical pickup 41 is connected by a ribbon cable 56 to control electronics 58. The control electronics 58 includes a laser diode driver (LD) 60 that supplies a current 62 to a laser diode 61 in the optical pickup 41, and receives from the laser diode 61 a power monitor signal 64. When the CD 43 is set spinning by a spindle motor 63 under the control of the control electronics 58, and the CD 43 is in view of the lens 2, a quadrant photodiode 65 sends a focus error signal 66 and a tracking error signal 67 to a corresponding focus error circuit 68 and tracking error circuit 69, which in turn are connected by connector 70 to a focus servo circuit 71 and a tracking servo circuit 72. The focus servo circuit 71 generates an appropriate focus correction signal 73, and the tracking servo circuit 72 generates both a coarse tracking correction signal 74 that is fed to the tracking motor 45, and a fine tracking correction signal 75. The focus and tracking correction signals 73,75 are then fed back to the focus and tracking coils 8,6 to keep the optical pickup 41 correctly focused

and on track.

When the optical pickup 41 is in the park position 48, the control electronics 58 can be used to keep the lens focus[s]ed on the focus object 50, and [so] avoid rattling of the optical pickup 41. This control electronics 50 can be activated whenever rattles might be expected. For example, if the optical media system 40 is part of a CD 43 played in a motor car (not shown), then the active control of focus in the parking position may be activated as soon as the motor vehicle is energi[s]zed by the driver.

In use with a CD 43, the laser power will be typically 1 mW. In order to reduce power consumption, and the heat absorbed by the focus object 50, the laser power at the focus position may be reduced to about 0.1 mW or less, either by pulsing the laser at a 10% duty cycle, or by reducing the laser power, or by a combination of these. Because the focus object 50 is not moving relative to the optical pickup 41, this reduced power should not unduly affect focus operation.

Figures 5 and 6 show another way in which the heat absorbed by the focus object 50 may be reduced. Figure 5 shows a plot of an S-shaped focus error signal 47 against defocus distance. The focus error signal 47 is zero outside ±40 nm of best focus. It is possible by introducing an offset into the derived focus error signal 47 to lock onto focus at any point on the curve of the focus error signal 47 with a sufficiently high slope, for example at a defocus distance d_0 of 20 nm. As can be seen in Figure 6, at this defocus distance, the focus spot size

S will be about 10 µm, which implies an energy density about 100 fold less that at the best focus at the focus waist W of about 1 µm.

In addition, the reflector layer 51 is about 250 µm thick in order to increase the ability of the reflector layer 51 to conduct [head] away from the focus spot S.

Figure 7 shows a second embodiment of an optical media system 80. This differs from the first embodiment 40 in that there is no focus object, and in that once the optical pickup 41 is in the park position 48, the focus coils 8 are energi[s]<u>z</u>ed to retract fully the lens 2 so that the <u>surrounding</u> cradle 4 is held securely against the upper stop 28. This is done with modified control electronics 81 in which a focus offset 82 is added to the focus servo 71. The <u>surrounding</u> cradle 4 can then be held against the upper <u>focus</u> end stop 28 with sufficient force so that expected vibration does not cause rattling of the <u>surrounding</u> cradle 4 against the <u>focus</u> end stops 28,30. An advantage of this embodiment is that there is no need to provide a focus object 50 which, although potentially quite inexpensive, does use a volume within the optical media system and add some small mechanical complexity.

Figure 8 shows a third embodiment of an optical media system 90. This differs from the first embodiment 40 in that there is no focus object, and from the second embodiment 80 in that the position of the lens 2 and <u>surrounding</u> cradle 4 is not controlled so that the <u>surrounding</u> cradle <u>4</u> is held against one of the <u>focus</u> end stops 28,30. There are two advantages to this approach.

The first is that there is no need to provide a focus object 50 and the second is that the focus actuator 1 is not biased fully in one direction, thereby avoiding any induced distortion over time to the [wire] suspension wires 16, 17, 18, 19 of the focus [and tracking] actuator 1.

In the park position 48 of Figure 8, the position of the lens 2 is held away from the focus end stops 28,30 by the detection of currents induced in the focus coil 8 by movement of the focus coil 8 in the static magnetic field of the permanent magnets 14. The currents are detected by modifying the control electronics 91 so that this includes a focus current detection circuit (FC) 92. An output 93 from the focus current detection circuit 92 is fed to the focus servo circuit 71, which then generates with a current mirror an opposite current which is fed back into the focus coils 8 to cancel partially the induced movement of the lens 2 and surrounding cradle 4. Although it is not possible to cancel entirely the movement of the lens 2 owing to inevitable lags between the detection of the induced current and the generation of a cancelling current, the movement can be controlled sufficiently to keep the surrounding cradle 4 from hitting the focus end stops 28, 30 owing to vibration in a moving motor car.

If tracking rattle is a problem, then the three embodiments described above may be modified so that instead of or in addition to the focus position being controlled, the tracking position is controlled. For example, in Figure 4, the focus object 50 may have tracking grooves arranged essentially parallel with

similar groves on the optical disc 43. The tracking servo 72 could then control the position of the lens 2 and cradle 4 to suppress or eliminate rattle in the tracking direction. In Figure 7, the <u>surrounding</u> cradle 4 could be moved left or right so that this came up against one or the other of the tracking end stops 36,37. In Figure 8, circuitry similar to that described for focus current detection and cancellation could be used to control tracking movement of the <u>surrounding</u> cradle 4 owing to vibration in the tracking direction.

The invention therefore provides a number of ways in which rattling of a focus and/or tracking actuator may be controlled in order to suppress or eliminate rattle induced by external vibrations of the optical media system. This is particularly useful in an automotive application, where in-vehicle rattles can be annoying to a driver or passengers.

Claims

1. An optical media system comprising: an optical pickup for reading from and/or writing to an optical storage medium, the optical pickup having one or more sources of light, an objective lens, a focus and/or tracking actuator for moving the lens to focus and/or track the light on the optical medium and mechanical limits to limit the focus and/or tracking movement of the lens; and an actuator controller for controlling the actuator and hence the focus and/or tracking position of the lens, characterised in that the actuator controller actively controls the lens position when the optical pickup is not being used with the optical medium.

2. (AMENDED) [An] The optical media system as claimed in Claim 1, in which the optical pickup is moved to a park position away from the optical medium when not being used with such an optical medium.

3. (AMENDED) [An] The optical media system as claimed in Claim 2, in which the system includes a focus object at the park position so that the actuator controller can focus the light on the focus object when the optical pickup is not being used with the optical medium in order to hold the lens position within the mechanical limits.

4. (AMENDED) An The optical media system as claimed in Claim 3, in which the lens is adapted to focus light through an optical substrate in order to read and/or write to the optical medium, and the focus object includes a similar substrate.

5. (AMENDED) [An] The optical media system as claimed in Claim 3 [or Claim 4], in which the actuator controls the lens position when the optical pickup is not being used with the optical medium so that the focus of light on the focus object is defocused in order to reduce the illuminance on the focus object.

6. (AMENDED) [An] The optical media system as claimed in [any of] Claim[s] 3 [to 5], in which the light is pulsed on the focus object.

7. (AMENDED) [An] The optical media system as claimed in [any of] Claim[s] 3 [to 6] in which the focus object contains thermally conductive material for dissipating heat absorbed from the focus light.

8. (AMENDED) [An] The optical media system as claimed in Claim 7, in which the focus object includes a reflective layer on which the focus actuator focuses, the thermally conductive material being a thickness of the reflective layer significantly beyond that needed for bulk reflectivity.

9. (AMENDED) [An] The optical media system as claimed in Claim 1 [or Claim 2], in which the actuator is a voice coil actuator, the actuator controller being connected to the voice coil actuator and including circuitry that detects a voltage or a current generated by externally induced movement of the voice coil when the optical pickup is not being used with the optical medium in order to generate a compensating voltage or current in order to

10. (AMENDED) [An] The optical media system as claimed in Claim 1 [or Claim 2], in which the optical pickup has at least one end stop that defines a limit to the focus and/or tracking movement of the lens, and the actuator controller biases the lens towards an end stop when the optical pickup is not being used with the optical medium so that the lens position is held at the end stop.

11. (AMENDED) [An] The optical media system as claimed in [any of] Claim[s] 1 [to 9], in which the optical pickup has a pair of end stops that define a limit to the focus and/or tracking movement of the lens, and the actuator controller controls the lens position to a median position between the end stops.

12. (AMENDED) [A vehicle comprising a motive means by which the vehicle may be energised to move, an optical media system, and an electrical power source to power the optical media system, the optical media system being as claimed in any preceding claim, in which the actuator controller actively controls the focus and/or tracking position of the lens when the vehicle is energised to move.] The optical media system as claimed in Claim 1, wherein the optical media system is mounted in a vehicle and wherein the actuator controller actively controls the focus and/or tracking position of the lens when the vehicle is moving.

10/030596
WO 01/04884 PCT/GB00/02595
PTO/PCT Rec'd 08 JAN 2002

Optical Media Pickup Anti-rattle

The present invention relates to an optical media system for suppressing externally induced rattle of an optical media pickup.

Optical media, such as optical discs, card or tape, are usually read and/or written to by an optical pickup containing an objective lens mounted in a voice coil actuator which performs focus and optionally tracking on the optical media. The objective lens is normally mounted in a carriage on a suspension, for example at the ends of flexible or hinged arms, with a biasing means that biases the lens to a neutral position often at the centre of a focussing range of about ± 1 mm. The focus motor is usually a voice coil actuator which moves between limits such as end stops that protect the focus actuator or lens from potential mechanical damage.

During normal operation in focussing on optical media, the end stops should never be reached, as a focus servo will keep the pickup focussed on the optical media. When the optical pickup is not being used, it may be moved off to one side of the optical media, so that the lens is no longer in position to read/write to/from the media.

The inventors have noted a problem with Compact Disc (CD) optical pickups in motor vehicles. Engine, road and wind noise reduction and rattle elimination is always desirable to provide for a quieter ride. In a very quiet car, rattles were noted in a CD player when the car was driven on a bumpy surface. The source of the noise was traced to the CD pickup hitting the focus end stops when the pickup was in a parked position, owing to vertical vehicle movement and vibrations.

It is an object of the present invention to provide an optical media pickup with improved rattle characteristics.

Accordingly, the invention provides an optical media system comprising: an optical pickup for reading from and/or writing to an optical storage medium, the optical pickup having one or more sources of light, an objective lens, a focus and/or tracking actuator for moving the lens to focus and/or track the light on the optical medium and mechanical limits to limit the focus and/or tracking movement of the lens; and an actuator controller for controlling the actuator and hence the focus and/or tracking position of the lens, characterised in that the actuator controller actively controls the lens position when the optical pickup is not being used with the optical medium.

Because the focus lens position is controlled, rattling of the actuator is suppressed or eliminated.

The mechanical limits may be defined by the construction of the optical pickup, for example being provided by end stops about the lens and separated by a spacing along an axial focus direction of the lens, or along a tracking direction transverse to the axial position.

The light may be any suitable visible or invisible light source, for example, near infra-red laser light or LED light.

The term optical media systems includes optical disc, tape and card systems. These include read-only systems such as those using compact disc media and read/write/erase systems such as those using magneto-optic data disc media.

The optical pickup will in general include focus detection means which generates a focus error signal when the pickup

is used to read from or write to the optical medium. The optical disc system will then contain focus servo electronics so that the focus actuator can be moved to keep the objective lens positioned correctly for focus on the optical medium.

In a preferred embodiment of the invention, the optical pickup is moved to a park position away from the optical medium when not being used with such an optical medium. Then, the system can include a focus object at the park position so that the actuator controller can focus the light on the focus object when the optical pickup is not being used with the optical medium in order to hold the lens focus position within the mechanical limits.

The focus object may advantageously be made to have similar optical characteristics to those of the optical medium. For example, if the optical medium has a transparent substrate through which the light is focussed to an information-bearing layer, then the lens will normally be adapted to focus light through this substrate in order to read and/or write to the optical medium. This is because focussing light through a planar substrate will introduce spherical aberration, which would result in an increase in focus spot size. The light from the focus lens is therefore pre-aberrated with an opposite spherical aberration so that this aberration is cancelled after the light has traversed the correct thickness of substrate.

The focus object may then include a substrate similar to that of the optical medium. This gives the advantage of reducing any adverse affects on focus due to dust or dirt on the focus object.

Because in practice the focus object cannot be perfectly reflective, the light on the focus object will generate heat where this is focussed. Therefore, the focus actuator

may control the lens position when the optical pickup is not being used with the optical medium so that the focus of light on the focus object is defocused in order to reduce the illuminance on the focus object. In this way, the heat generated by the focussed light may be reduced.

Such an optical defocus may be obtained by injecting a focus offset signal into the electronic focus servo loop to the focus actuator.

Alternatively or additionally, the light may be pulsed on the focus object in order to reduce the average illuminance. When the focus servo uses light returned from the focus object to generate a focus error signal for a feedback servo to the focus actuator, the pulsing of light should be set so that a sufficiently strong focus error signal may still be generated. Because the focus object is fixed, unlike the optical medium, the average light intensity on the focus object may made less than that on the optical medium.

The focus object may contain thermally conductive material for dissipating heat absorbed from the focus light. For example, the focus object may include a reflective layer on which the focus actuator focuses, the thermally conductive material being a thickness of the reflective layer significantly beyond that needed for bulk reflectivity.

For example, in the case of an aluminium reflector layer, about 40 nm to 50 nm thickness is needed in order to achieve a bulk reflectivity of about 95% at 830 nm. If the thickness is increased to about 250 nm, then the aluminium layer will be able to conduct about five times as much heat from the focus area.

The focus or tracking actuator may be a voice coil

actuator, the actuator controller being connected to the voice coil actuator and including circuitry that detects a voltage or a current generated by externally induced movement of the voice coil when the optical pickup is not being used with the optical medium in order to generate a compensating voltage or current in order to control the lens position.

The optical pickup may have at least one end stop that defines a limit to the focus and/or tracking movement of the lens. The actuator controller can then bias the lens towards an end stop when the optical pickup is not being used with the optical medium so that the lens position is held at the end stop.

Alternatively, when the optical pickup has a pair of end stops that define a limit to the focus (or tracking) movement of the lens, the actuator controller may control the lens position to a median position between the end stops.

The optical media system may be used in a vehicle, such as a motor car, comprising a motive means by which the vehicle may be energised to move. The vehicle will in general have an electrical power source to power the optical media system. The actuator controller then actively controls the focus position of the lens when, and preferably only when, the vehicle is energised to move.

The invention will now be further described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic view of a focus and tracking actuator of an optical pickup as seen from inside the pickup along the optical axis of an objective lens;

Figure 2 is a cross-section through the actuator of Figure 1, taken along line II-II;

Figure 3 is a cross-section through the actuator of Figure 1, taken along line III-III;

Figure 4 is a schematic drawing of an optical media system according to a first embodiment of the invention, showing an optical pickup with the actuator of Figure 1, with associated control electronics and an optical disc;

Figure 5 is a plot of focus error signal against defocus distance;

Figure 6 is a schematic drawing showing how defocus and a relatively thick reflector layer can be used to reduce heat absorbed from a focus spot of the optical pickup;

Figure 7 is a schematic drawing of an optical media system according to a second embodiment of the invention; and

Figure 8 is a schematic drawing of an optical media system according to a third embodiment of the invention.

Figures 1, 2 and 3 show a focus and tracking voice coil actuator 1 of conventional design for an optical pickup. The actuator has an objective lens 2 with a numerical aperture of 0.6 held in a surrounding cradle 4. The cradle 4 supports pairs of coils 6,8. One pair of coils 6 has a common axis 10 transverse to an optical axis 12 of the lens, and serves as a tracking actuator. The other pair of coils 8 has a common axis coincident with the optical axis 12 and serves as a focus actuator.

When electrical current is passed through a pair of coils 6,8, this generates a magnetic field which then interacts with a permanent magnetic field produced by a pair of permanent magnets 14 on opposite sides of the optical axis 12, in order to drive the cradle and objective lens along either the tracking axis 10 or the focus axis 12.

The cradle is supported by four straight suspension wires 16,17,18,19, which are arranged in pairs 16,17 and 18,19. As shown in Figure 2, one pair 16,17 is generally above the coils 6,8 and the other pair 18,19 is generally below the coils 6,8. The wires all terminate at one end away from the cradle at corresponding electrical terminals 20 on a terminal block 22, and at the other end to corresponding terminals 24 to which ends of the coils 6,8 are wired. Therefore, current to drive the focus and tracking actuator 1 is supplied to the coils through the suspension wires 16-19.

Tension in the wires 16-19 when these are moved away from a neutral position creates biasing forces, which will tend to return the cradle 4 to a neutral position.

The terminal block supports a frame 26 that extends fully around the cradle 4 in a plane transverse to the optical axis 12 of the lens 2.

The frame 26 in turn supports a pair of end stops 28,30 shown most clearly in Figure 2, one of which 28 extends frame-like about the optical axis 12 above the cradle, and the other of which 30 consists of a pair of ledges 31,32 that are inwardly directed towards the lens 2 in a plane generally below the cradle 4.

When the focus actuator is driven fully inwards, a top surface 34 of the cradle 4 contacts the upper stop 28, and when the focus actuator is driven fully outwards, a bottom surface 35 of the cradle 4 contacts the lower stop 30.

The frame 26 has a pair of inwardly directed projections 36,37, which act as stops in the tracking direction.

The focus and tracking stops 28,30,36,37 act to protect the focus and tracking actuator 1, and particularly the suspension wires 16-19, from mechanical damage which would occur at an extreme movement of the cradle 4 relative to the terminal block 22.

It has been discovered that in a motor car vibrations from the road cause a rattling between the cradle and focus end stops 28,30, but not between the cradle and tracking end stops. There are two reasons for this. One is that vibrations tend to be strongest in a vertical direction, which normally coincides with the optical axis 12, and the other is that the stiffness of the suspension wire to movement of the cradle in the tracking direction can be greater than in the focus direction. This difference in stiffness is due to the fact that the required frequency response of the tracking actuator is less than that required from the focus actuator.

Figure 4 shows a first embodiment of the invention 40, in which the focus and tracking actuator 1 is incorporated in a conventional optical disc pickup 41. The pickup is shown

focussing a beam of laser light 42 from the lens 2 onto a compact disc (CD) 43. The pickup 41 is mounted on rail 39 of a conventional linear tracking actuator 44 driven by a coarse tracking motor (TM) 45. The tracking motor 45 can move the optical pickup 41 so that the lens 2 can focus on an innermost portion 46 the CD 43. When the pickup is not being used to read from the CD, the tracking motor 45 can move 47 the optical pickup away from the CD 43 to a park position 48, as shown by the optical pickup 41 drawn in phantom.

A focus object 50 is provided at the park position 48 on which the lens 2 may focus. The focus object consists of a an aluminium reflector layer 51 encapsulated by a transparent substrate 52 of 1.1 mm thick polycarbonate, a lacquer backing layer 53, held in a surrounding moulded plastic cup 54.

When the lens 2 is focussed on the focus object 50, the position of the cradle 4 along the focus axis 12 is actively controlled so that the cradle is restrained from rattling against the focus end stops 28,30.

A person skilled in the art will be familiar with the conventional operation of an optical pickup, and so this will be described only briefly. The optical pickup 41 is connected by a ribbon cable 56 to control electronics 58. The control electronics 58 includes a laser diode driver (LD) 60 that supplies a current 62 to a laser diode 61 in the optical pickup, and receives from the laser diode 61 a power monitor signal 64. When the CD 43 is set spinning by a spindle motor 63 under the control of the control electronics 58, and the CD 43 is in view of the lens 2, a quadrant photodiode 65 sends a focus error signal 66 and a tracking error signal 67 to a corresponding focus error circuit 68 and tracking error circuit 69, which in turn are connected 70 to a focus servo circuit 71 and a

tracking servo circuit 72. The focus servo circuit generates an appropriate focus correction signal 73, and the tracking servo circuit 72 generates both a coarse tracking correction signal 74 that is fed to the tracking motor 45, and a fine tracking correction signal 75. The focus and tracking correction signals 73,75 are then fed back to the focus and tracking coils 8,6 to keep the optical pickup 41 correctly focused and on track.

When the optical pickup 41 is in the park position 48, the control electronic can be used to keep the lens focussed on the focus object, and so avoid rattling of the optical pickup 41. This control can be activated whenever rattles might be expected. For example, if the optical media system 40 is part of a CD played in a motor car (not shown), then the active control of focus in the parking position may be activated as soon as the motor vehicle is energised by the driver.

In use with a CD, the laser power will be typically 1 mW. In order to reduce power consumption, and the heat absorbed by the focus object 50, the laser power at the focus position may be reduced to about 0.1 mW or less, either by pulsing the laser at a 10% duty cycle, or by reducing the laser power, or by a combination of these. Because the focus object is not moving relative to the optical pickup 41, this reduced power should not unduly affect focus operation.

Figures 5 and 6 show another way in which the heat absorbed by the focus object 50 may be reduced. Figure 5 shows a plot of an S-shaped focus error signal 47 against defocus distance. The focus error signal 47 is zero outside $\pm 40\ \mu m$ of best focus. It is possible by introducing an offset into the derived focus error signal to lock onto focus at any point on the curve 47 with a sufficiently high slope, for example at a defocus distance d_0 of 20 μm. As can be seen in Figure 6, at

this defocus distance, the focus spot size S will be about 10 μm, which implies an energy density about 100 fold less that at the best focus at the focus waist W of about 1 μm.

In addition, the reflector layer 51 is about 250 μm thick in order to increase the ability of the reflector layer 51 to conduct head away from the focus spot S.

Figure 7 shows a second embodiment of an optical media system 80. This differs from the first embodiment 40 in that there is no focus object, and in that once the optical pickup 41 is in the park position 48, the focus coils 8 are energised to retract fully the lens 2 so that the cradle 4 is held securely against the upper stop 28. This is done with modified control electronics 81 in which a focus offset 82 is added to the focus servo 71. The cradle 4 can then be held against the upper end stop 28 with sufficient force so that expected vibration does not cause rattling of the cradle 4 against the end stops 28,30. An advantage of this embodiment is that there is no need to provide a focus object 50 which, although potentially quite inexpensive, does use a volume within the optical media system and add some small mechanical complexity.

Figure 8 shows a third embodiment of an optical media system 90. This differs from the first embodiment 40 in that there is no focus object, and from the second embodiment 80 in that the position of the lens 2 and cradle 4 is not controlled so that the cradle is held against one of the end stops 28,30. There are two advantages to this approach. The first is that there is no need to provide a focus object 50 and the second is that the focus actuator is not biased fully in one direction, thereby avoiding any induced distortion over time to the wire suspension of the focus and tracking actuator.

In the park position 48 of Figure 8, the position of the lens 2 is held away from the end stops 28,30 by the detection of currents induced in the focus coil 8 by movement of the focus coil in the static magnetic field of the permanent magnets 14. The currents are detected by modifying the control electronics 91 so that this includes a focus current detection circuit (FC) 92. An output 93 from the focus current detection circuit 92 is fed to the focus servo, which then generates with a current mirror an opposite current which is fed back into the focus coils 8 to cancel partially the induced movement of the lens 2 and cradle 4. Although it is not possible to cancel entirely the movement of the lens owing to inevitable lags between the detection of the induced current and the generation of a cancelling current, the movement can be controlled sufficiently to keep the cradle 4 from hitting the end stops owing to vibration in a moving motor car.

If tracking rattle is a problem, then the three embodiments described above may be modified so that instead of or in addition to the focus position being controlled, the tracking position is controlled. For example, in Figure 4, the focus object 50 may have tracking grooves arranged essentially parallel with similar groves on the optical disc 43. The tracking servo 72 could then control the position of the lens 2 and cradle 4 to suppress or eliminate rattle in the tracking direction. In Figure 7, the cradle 4 could be moved left or right so that this came up against one or the other of the tracking end stops 36,37. In Figure 8, circuitry similar to that described for focus current detection and cancellation could be used to control tracking movement of the cradle 4 owing to vibration in the tracking direction.

The invention therefore provides a number of ways in which rattling of a focus and/or tracking actuator may be

controlled in order to suppress or eliminate rattle induced by external vibrations of the optical media system. This is particularly useful in an automotive application, where in-vehicle rattles can be annoying to a driver or passengers.

Claims

1. An optical media system (40) comprising: an optical pickup (41) for reading from and/or writing to an optical storage medium (43), the optical pickup (41) having one or more sources of light (61), an objective lens (2), a focus and/or tracking actuator (1) for moving the lens (2) to focus and/or track the light (61) on the optical medium (43) and mechanical limits (28,30,36,37) to limit the focus and/or tracking movement of the lens (2); and an actuator controller (58) for controlling the actuator (1) and hence the focus and/or tracking position of the lens (2), characterised in that the actuator controller (58) actively controls the lens position when the optical pickup (41) is not being used with the optical medium (43).

2. An optical media system (40) as claimed in Claim 1, in which the optical pickup (41) is moved to a park position away from the optical medium (43) when not being used with such an optical medium (43).

3. An optical media system (40) as claimed in Claim 2, in which the system includes a focus object (50) at the park position so that the actuator controller (58) can focus the light (61) on the focus object (50) when the optical pickup (41) is not being used with the optical medium (43) in order to hold the lens position within the mechanical limits (28,30).

4. An optical media system (40) as claimed in Claim 3, in which the lens (2) is adapted to focus light (61) through an optical substrate in order to read and/or write to the optical medium (43), and the focus object includes a similar substrate (52).

5. An optical media system (40) as claimed in Claim 3 or Claim 4, in which the actuator controls the lens position when the optical pickup (41) is not being used with the optical medium (43) so that the focus of light (61) on the focus object is defocused in order to reduce the illuminance on the focus object (50).

6. An optical media system (40) as claimed in any of Claims 3 to 5, in which the light (61) is pulsed on the focus object (50).

7. An optical media system (40) as claimed in any of Claims 3 to 6 in which the focus object (50) contains thermally conductive material (51) for dissipating heat absorbed from the focus light (61).

8. An optical media system (40) as claimed in Claim 7, in which the focus object (50) includes a reflective layer (51) on which the focus actuator (1) focuses, the thermally conductive material being a thickness of the reflective layer significantly beyond that needed for bulk reflectivity.

9. An optical media system (40) as claimed in Claim 1 or Claim 2, in which the actuator is a voice coil actuator (1), the actuator controller (58) being connected to the voice coil actuator (1) and including circuitry (92) that detects a voltage or a current generated by externally induced movement of the voice coil when the optical pickup (41) is not being used with the optical medium (43) in order to generate a compensating voltage or current (71) in order to control the lens position.

10. An optical media system (40) as claimed in Claim 1 or Claim 2, in which the optical pickup (41) has at least one end stop (28,30,36,37) that defines a limit to the focus and/or tracking movement of the lens (2), and the actuator controller (58) biases the lens (2) towards an end stop (28,30,36,37) when the optical pickup (41) is not being used with the optical medium (43) so that the lens position is held at the end stop (28,30,36,37).

11. An optical media system (40) as claimed in any of Claims 1 to 9, in which the optical pickup (41) has a pair of end stops (28,30,36,37) that define a limit to the focus and/or tracking movement of the lens (2), and the actuator controller (58) controls the lens position to a median position between the end stops (28,30,36,37).

12. A vehicle comprising a motive means by which the vehicle may be energised to move, an optical media system (40), and an electrical power source to power the optical media system (40), the optical media system being as claimed in any preceding claim, in which the actuator controller (58) actively controls the focus and/or tracking position of the lens (2) when the vehicle is energised to move.

Abstract

[Optical Media Pickup Anti-rattle]

The present invention relates to an optical media system (40) for suppressing externally induced rattle of an optical media pickup. The system (40) comprises: an optical pickup (41) for reading from and/or writing to an optical storage medium (43), the optical pickup (41) having one or more sources of light (61), an objective lens (2), a focus and/or tracking actuator (1) for moving the lens (2) to focus and/or track the light on the optical medium (43) and mechanical limits to limit the focus and/or tracking movement of the lens (2); and an actuator controller (58) for controlling the actuator (1) and hence the focus and/or tracking position of the lens (2), characterised in that the actuator controller (58) actively controls the lens position when the optical pickup (41) is not being used with the optical medium (43).

Figure 4

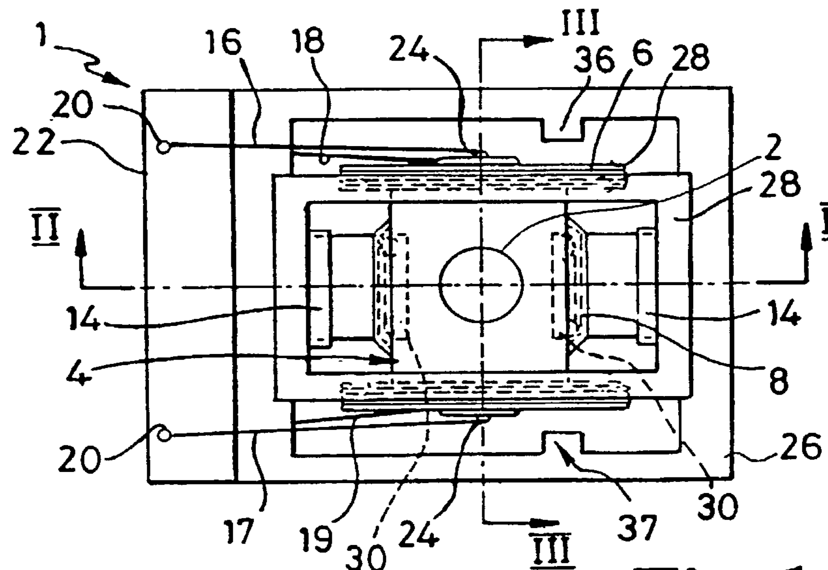

Fig. 1

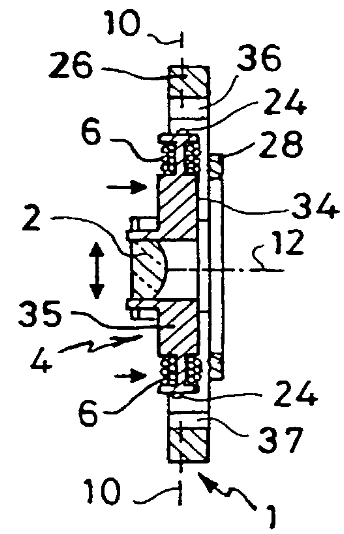

Fig. 3

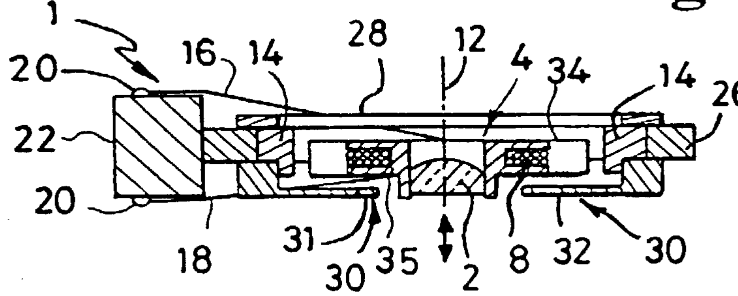

Fig. 2

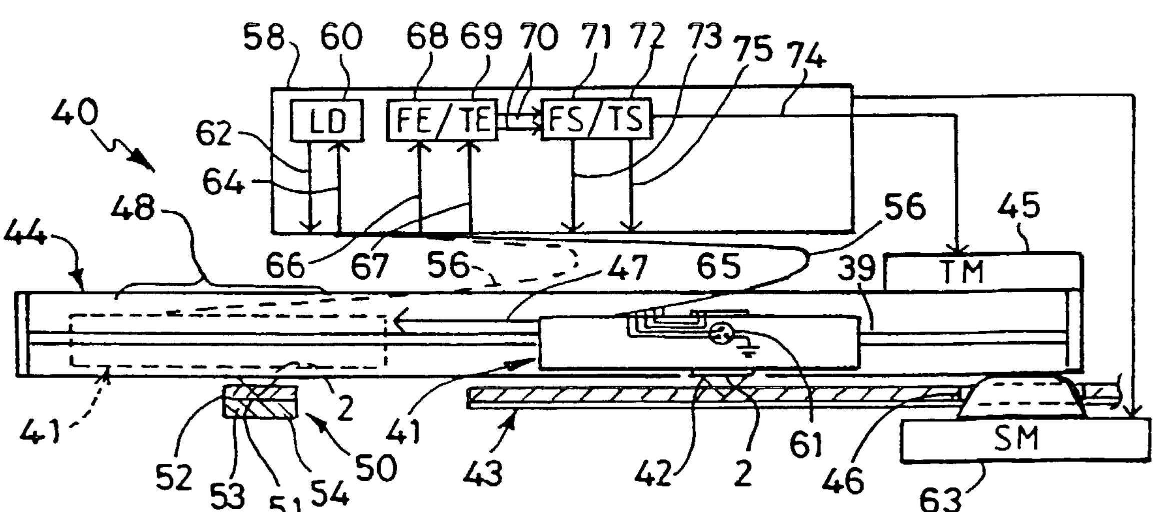

Fig. 4

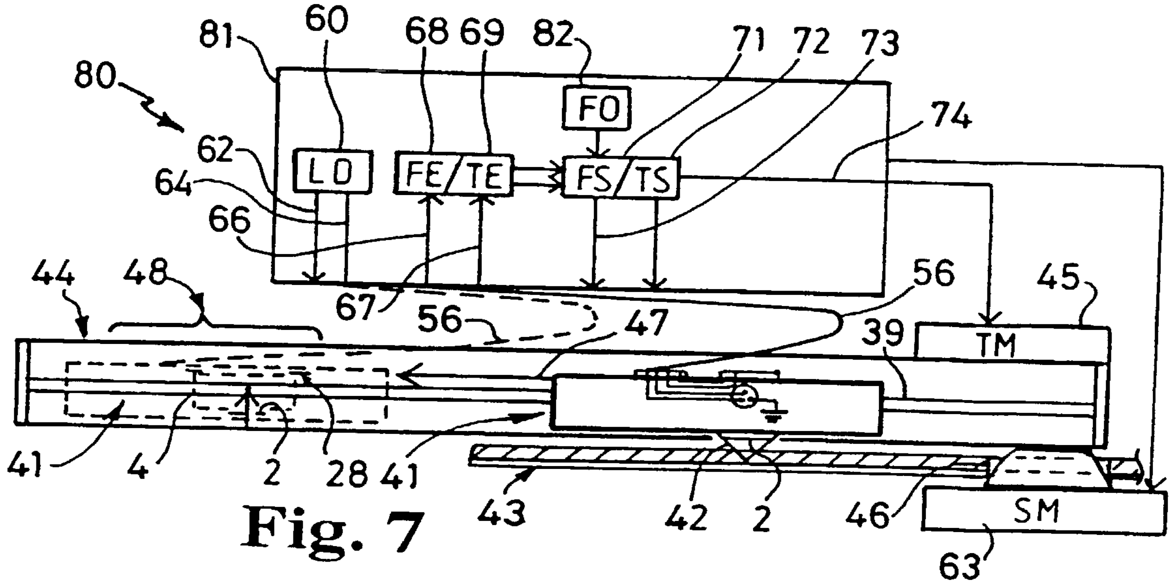

Fig. 7

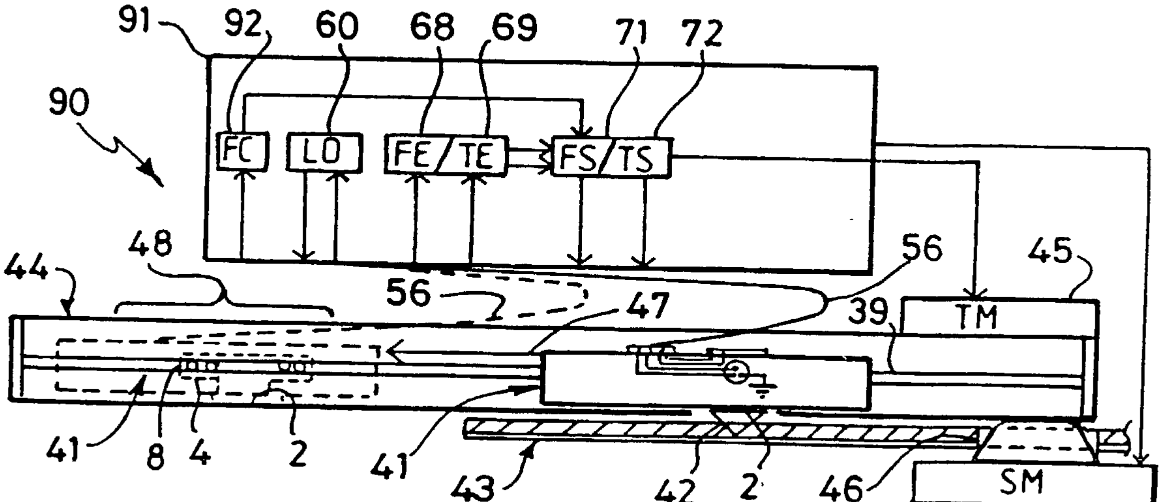

Fig. 8

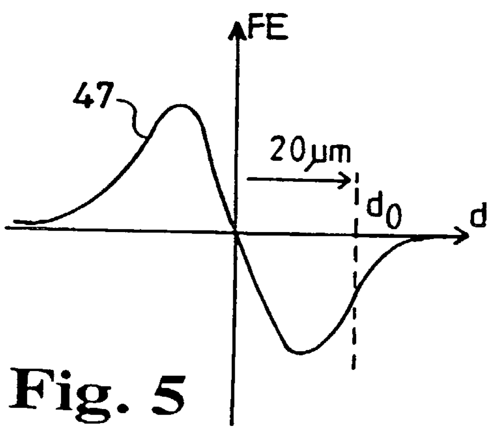

Fig. 5

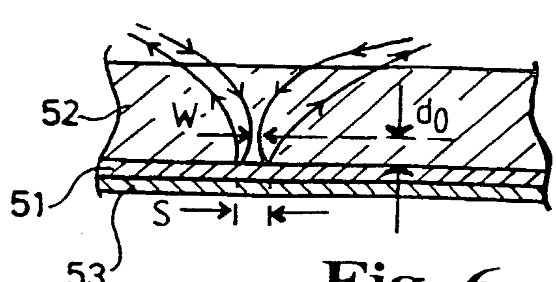

Fig. 6

Attorney Docket No.: 10541-751
Visteon Case No.: 198-1516

DECLARATION AND POWER OF ATTORNEY ORIGINAL APPLICATION

As a below named inventor, I hereby declare:

My residence, post office address and citizenship are as stated below next to my name;

I believe I am the original, first and sole inventor or an original, first and joint inventor of the subject matter that is claimed and for which a patent is sought on the invention entitled:

OPTICAL MEDIA PICKUP ANTI-RATTLE

the specification of which was filed on January 8, 2002 as U.S. Serial No.10/030,596.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge my duty to disclose to the United States Patent and Trademark Office all information that I know to be material to the patentability of this application as defined in Title 37 C.F.R. § 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d) or Section 365(b) of any foreign application(s) for patent or inventor's certificate, or Section 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s): Priority Not Claimed

(Number)	(Country)	(Filing Date)	Priority Not Claimed
GB 9915867.7	Great Britain	July 8, 1999	☐
			☐
			☐

I hereby claim the benefit under 35 U.S. C. Section 119(e) of any United States provisional application(s) listed below:

(Application Serial No.)	(Filing Date)

I hereby claim the benefit under 35 U.S.C. Section 120 of any United States applications(s), or Section 365(c) of any PCT International Application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. Section 112, I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, C.F.R., Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application.

PCT/GB00/02595	July 5, 2000	Pending
(Application Serial No.)	(Filing Date)	(Status: patented, pending, abandoned)
(Application Serial No.)	(Filing Date)	(Status: patented, pending, abandoned)
(Application Serial No.)	(Filing Date)	(Status: patented, pending, abandoned)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorneys, agents, and each shareholder, attorney of counsel, associate, and employee of Brinks Hofer Gilson & Lione, who is a registered Patent Attorney or registered Patent Agent, my attorney with full power of substitution and revocation to prosecute this application and transact all business in the United States Patent and Trademark Office connected therewith and to act on my behalf before the competent International Authorities in connection with any and all international applications filed by me.

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Fourth inventor's signature		Date
Residence		
Citizenship		
Post Office Address		

Full name of fifth inventor, if any		
Fifth inventor's signature		Date
Residence		
Citizenship		
Post Office Address		

Full name of sixth inventor, if any		
Sixth inventor's signature		Date
Residence		
Citizenship		
Post Office Address		